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OUT-OF-MARKET BULK MILK SHIPMENT CHARGES FOR SELECTED FEDERAL ORDER MARKETS

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ABSTRACT

Bulk milk shipments to destinations outside seven Federal milk order markets were analyzed on the basis of hauling charge per hundredweight, per hundredweight mile, and total shipment. Multiple regression techniques were used to estimate these charges, based on distance and volume of milk transported. Use of the segmented-type estimating equation provided estimates of hauling charges within 10 percent of actual costs more than 80 percent of the time.

Key Words: Milk hauling charges, Bulk milk transport, Dairy, Multiple regression.

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SUMMARY

Distance and load size generally explain most of the difference in charges for hauling bulk milk between markets. However, the degree of variability in the charges for spot shipments indicates the importance of other factors and the need to consider them as part of the price-making process.

About three-fourths of all intermarket shipments made by Federal milk order markets during October 1969 were made by the seven markets represented in this study. On a combined market basis, hauling charges per hundredweight of bulk milk transported ranged from $0.15 to $2.74; on a per hundredweight mile basis, they were between 0.1268 and 0.7659 cent. Total charges ranged from $56 to $1,288.

Using the procedure developed in this study, charges for spot shipments of out-of-market bulk milk were estimated within 10 percent of actual charges more than 80 percent of the time. The procedure was developed as an aid in making decisions about location differentials in milk market orders.

OUT-OF-MARKET BULK MILK SHIPMENT CHARGES FOR SELECTED FEDERAL ORDER MARKETS

by

Herbert H. Moede

INTRODUCTION

Background and Objectives

In the past, maintaining the quality of bulk milk while it was being transported to market tended to limit the distance of shipment. Improvements in transportation and handling facilities, such as tank trailers, highways, and bulk storage tanks, have helped to resolve this problem. Today, bulk milk is being moved greater distances between production areas and consuming markets, as well as between marketing areas.

This study had two major objectives: (1) Determine the relationship between hauling charges currently being paid for out-of-market area "spot" bulk milk shipments, distance hauled, and quantity of milk shipped per shipment; and (2) develop a procedure to estimate bulk milk hauling charges, based on distance and quantity of milk transported.

Definitions

For purposes of this study, the terms out-of-market area shipment and spot shipment are defined as follows:

> Out-of-market shipment is a shipment of bulk milk from or to a plant within one of the selected order market areas from or to a plant located outside the area's boundaries as defined in the market order.
>
> Spot shipment is a quantity of bulk milk that is not regularly shipped between two specified plants or locations (that is, a daily, twice daily, or greater frequency). The shipment is not included among those regular shipments which are covered by a written or oral agreement between a shipper and hauler. The number of shipments between a specific shipping and receiving location does not exceed 15 shipments per month.

METHODOLOGY

Source of Data

In the summer and fall of 1970, data on out-of-market area bulk milk shipments during October 1969 were collected from seven Federal milk order markets--Chattanooga, Chicago Regional, Delaware Valley, Louisville-Lexington-Evansville, Minneapolis-St. Paul, Nashville, and North Central Iowa (table 1). 1/

Records of market administrators or milk shippers provided information on hauling charges per hundredweight of milk hauled, shipping and receiving cities, and the number of pounds of bulk milk in a shipment. One-way mileage between shipping and receiving cities was obtained from the Standard Highway Mileage Guide. 2/ Charges per hundredweight mile were calculated by dividing the reported charge per hundredweight by the distance the milk was shipped. Some data obtained were not used in the analysis because they did not meet the definition of out-of-market or spot shipments.

Data Characteristics

Load sizes in three of the seven market areas were within a relatively narrow range--about 44,000 to 49,000 pounds per shipment (that is, 5,200 to 5,700 gallons). For the remaining markets, the shipping quantities ranged from 8,100 (942 gallons) to 52,500 pounds (6,100 gallons) per load.

Greater variations existed between the markets in terms of hauling distance than were recorded for the quantity shipped per load--for example, a range of 60 to more than 1,700 miles. Mileages ranging between 1,600 and 1,700 primarily represent shipments from the Midwest to the extreme southeastern portion of the country.

On a combined market basis, most shipments (76 percent) weighed between 45,000 and 55,000 pounds. In terms of shipping distance, 66 percent of all shipments were transported 500 miles or less, while another 22 percent of the trips were for distances of 500 to 1,000 miles in length. The remaining 12 percent of the trips exceeded 1,000 miles between shipping and receiving points.

Hauling charges, either per hundredweight or per hundredweight mile, showed wide variations between market areas. On a consolidated basis, hauling charges used in the analysis ranged from $0.15 to $2.74 per hundredweight of bulk milk transported (table 2). Fifty-seven percent of the charges were between $0.15 and $0.59 per hundredweight; 29 percent within $0.65 to $1.09 range; 2 percent between $1.30 and $1.39 per hundredweight; and the remainder (12 percent) in the $2.20 to $2.75 per hundredweight class.

1/ Steven G. Levine, Agricultural Economist, Dairy Division, Agricultural Marketing Service, collected the data for use in the study. To prevent possible disclosure of an individual firm's charges, the seven markets are identified by letter code throughout this report instead of by market name.

2/ Standard Highway Mileage Guide, Rand McNally & Co., Chicago, Ill., 1968.

Table 1.--Selected characteristics of data used in analysis of hauling charges, seven Federal milk order markets, October 1969

Federal milk order market	Observations	Range of total charges	Range of charges per hundredweight	Range of charges per hundredweight mile	Range of one-way distance hauled	Range of load sizes
	Number	Dollars	Dollars	Cents	Miles	Hundredweights
A	43	162.05-1197.10	0.35-2.61	0.1268-0.1655	276-1691	440.0-489.2
B	51	73.68-244.50	0.15-0.50	0.1298-0.2500	60-369	445.4-489.8
C	10	94.87-626.98	0.20-1.36	0.1478-0.1770	113-884	460.0-474.4
D	84	117.87-529.76	0.30-1.10	0.1419-0.1908	191-708	265.8-525.0
E	64	72.75-148.80	0.22-0.42	0.1508-0.2745	102-185	281.3-496.8
F	78	89.81-1287.80	0.19-2.74	0.1357-0.2448	140-1736	257.1-479.8
G	55	56.85-363.13	0.17-0.81	0.1376-0.7659	91-586	81.0-450.5
Seven markets combined	385	56.35-1287.80	0.15-2.74	0.1268-0.7659	60-1736	81.0-525.0

Table 2.--Distribution of hauling charges used in analysis of out-of-market area bulk milk shipments on basis of charge per hundredweight and per hundredweight mile, seven Federal milk order markets, October 1969

Charge per hundredweight	Observations	Percentage of total 1/	Charge per hundredweight mile	Observations	Percentage of total 1/
Dollars	Number	Percent	Cents	Number	Percent
0.1500-0.1999	5	1.30	0.1200.0.1299	9	2.3
.2000- .2499	21	5.45	.1300- .1399	40	10.4
.2500- .2999	36	9.35	.1400- .1499	62	16.1
.3000- .3499	33	8.57	.1500- .1599	143	37.1
.3500- .3999	49	12.73	.1600- .1699	47	12.2
.4000- .4499	16	4.16	.1700- .1799	30	7.8
.4500- .4999	23	5.97	.1800- .1899	12	3.1
.5000- .5499	25	6.49	.1900- .1999	1	.3
.5500- .5999	11	2.86	.2000- .2099	1	.3
			.2100- .2199	12	3.1
.6500- .6999	20	5.19	.2200- .2299	5	1.3
.7000- .7499	8	2.08	.2300- .2399	0	0
.7500- .7999	18	4.68	.2400- .2499	1	.3
.8000- .8499	26	6.75	.2500- .2599	1	.3
.8500- .8999	4	1.04	.2600- .2699	0	0
.9000- .9499	8	2.08	.2700- .2799	4	1.0
.9500- .9999	3	.78			
1.0000-1.0499	14	3.64			
1.0500-1.0999	12	3.12	.4500- .4599	2	.5
			.4600- .4699	8	2.1
1.3000-1.3499	6	1.56	.4700- .4799	2	.5
1.3500-1.3999	1	.26	.4800- .4899	1	.3
2.2000-2.2499	5	1.30			
2.2500-2.2999	12	3.12	.7400- .7499	3	.8
2.3000-2.3499	6	1.56	.7500- .7599	0	0
2.3500-2.3999	8	2.08	.7600- .7699	1	.3
2.4000-2.4499	3	.78			
2.4500-2.4999	2	.52			
2.5000-2.5499	1	.26			
2.5500-2.5999	1	.26			
2.6000-2.6499	4	1.04			
2.6500-2.6999	2	.52			
2.7000-2.7499	2	.52			
Total	385	100.00		385	100.0

1/ Percentages may not add to 100 because of rounding

When these rates are converted to a charge per hundredweight mile, a substantially different type of distribution is displayed--95.6 percent of all observations were between 0.1200 and 0.2799 cent per hundredweight mile. About 66 percent of the 385 observations were within the 0.1400 to 0.1699 cent range. The remainder of the observations were distributed as follows: 3.4 percent were in the 0.4500 to 0.4899-cent and 1.1 percent in the 0.7400 to 0.7699-cent charge per hundredweight mile group.

Out-of-market bulk milk shipments from all Federal milk order markets during October 1969 were estimated to be 65-68 million pounds. The October 1969 sample of shipments for seven markets amounted to 17,235,000 pounds of bulk milk (table 3). Total shipments of these markets are estimated to represent 75 to 77 percent of the total quantity of milk included in all out-of-market bulk milk shipments made by Federal milk order markets for October.

Table 3.--Comparison of sample out-of-market bulk milk shipments with estimated total out-of-market milk shipments, seven Federal milk order markets, October 1969

Federal milk order market	Sample out-of-market bulk milk shipments	Estimated total out-of-market bulk milk shipments	Sample shipments as percentage of total out-of-market bulk milk shipments
	-------1,000 Pounds	----------	Percent
A	2,016	4,084	49.4
B	2,474	11,803	21.0
C	466	7,531	6.2
D	3,868	4,606	84.0
E	2,958	6,545	45.2
F	3,618	7,670	47.2
G	1,835	9,160	20.0
Seven-market total	17,235	51,399	33.5

On an individual market basis, the sample shipments represented 6.2 to 84.0 percent of the estimated quantity of bulk milk shipped from an individual market area during October 1969. On a consolidated basis, the sample accounted for about 33 percent of all bulk milk shipped from the seven markets.

ANALYSIS OF DATA

Procedure

A least squares multiple regression analysis was used to determine the statistical relationship between one dependent variable (Y) and two independent variables (X_1, X_2). For study purposes, this relationship was assumed to be represented by a straight line and is described by the following equation:

$$Y = a + b_1 X_1 + b_2 X_2 \tag{1}$$

Where:

Y = Hauling charges in dollars per hundredweight or cents per hundred weight mile

X_1 = One-way distance hauled in miles

X_2 = Load size--hundredweights of bulk milk hauled

b_1, b_2 = Partial regression coefficients for X_1 and X_2

a = Constant

The constant, a, in the formula serves to adjust the regression line upward or downward, based on the values of X_1, X_2, and Y. The partial regression coefficients (b_1, b_2) state the effect that changes in the values of X_1 and X_2 will have on the value of Y. These coefficients may be either negative or positive values. After values had been computed for a, b_1, and b_2, using all observations in the specified markets and for all seven markets combined, the regression equation was used to estimate hauling charges for transporting certain quantities of milk specified hauling distances.

Charge per Hundredweight Basis

Table 4 shows the computed estimated values of the multiple linear regression functions for all seven markets on both an individual and combined market basis. Individual market regression coefficients for one-way distance in miles hauled (b_1) were all positive and varied between 0.00108 and 0.00161. For example, using the b_1 value for market A, when the quantity of milk hauled is held constant, each mile increase in distance hauled increased the spot hauling charge by 0.00152 (0.15 cent). A 100-mile increase in distance hauled increased the hauling charge by 15.2 cents per hundredweight.

Regression coefficients for the number of hundredweights hauled (b_2) were negative for all but one market--market F. They ranged from + 0.00002 to -0.00207. This meant that an increase in the number of hundredweights transported would be reflected in a decrease in the charge per hundredweight, except

Table 4.--Estimates of multiple linear regression functions for out-of-market area bulk milk hauling charges, seven Federal milk order markets, October 1969

Federal milk order market	Observations	Average hauling charge per hundredweight, Y	Average one-way distance hauled, X_1	Average load size hundredweights hauled, X_2	Constant, a	Regression coefficients[1/]		R^2	Standard error of estimate
						Distance hauled (miles), b_1	Hundredweights hauled, b_2		
	No.	Dol.	Miles	Cwt.					Dol.
A	43	1.08	714.91	468.83	0.96667	0.00152 (127.83)	-0.00207 (4.20)	0.99758	0.03651
B	51	.42	301.65	485.14	.28405	.00111 (33.04)	-.00041 (1.20)	.96083	.01601
C	10	1.03	672.10	465.68	.47284	.00144 (62.84)	-.00088 (1.49)	.99922	.01623
D	84	.71	436.83	460.48	.15008	.00161 (34.56)	-.00030 (2.53)	.94465	.06848
E	64	.27	151.08	462.26	.29718	.00108 (10.26)	-.00042 (7.93)	.67027	.02118
F	78	1.43	898.67	463.80	.01248	.00156 (132.74)	.00002 (0.07)	.99594	.05989
G	55	.49	264.78	333.67	.50165	.00143 (27.55)	-.00116 (18.81)	.93590	.04903
Seven markets combined	385	.76	477.34	447.46	.40284	.00155 (193.97)	-.00085 (20.78)	.98997	.06592

[1/] T-values included in parentheses under regression coefficients.

in market F. For example, using the b_2 value for market A, when the distance transported is held constant, each 100-pound increase in the quantity of milk hauled is associated with a decrease of 0.21 cent in the charge per hundredweight. In market F, the b_2 value was a positive but negligible value (0.00002), indicating that, for this market, an increase in the number of hundredweights carried per shipment is accompanied by a small increase in the charge per hundredweight.

Except for one market where the R^2 value was 0.67027, the statistical measure of how well the regression line fitted the sample data ranged from 0.93590 to 0.99922. This indicates that most of the variations in the Y values (charge per hundredweight) were explained by or associated with changes in the distance milk was hauled (X_1) and the quantity hauled (X_2).

Standard errors of the estimate ranged from 1.60 cents for market B to 6.85 cents for market D. This statistical measure indicates the amount of variation likely to exist between an actual market hauling charge per hundredweight of milk hauled and one estimated by converting the regression format to an estimating equation. It is obtained by inserting the computed a, b_1, and b_2 values in the original function equation (table 4) and computing an estimated hauling charge per hundredweight ($\hat{Y}$). The format for the estimating equation is:

$$\hat{Y} = a + b_1X_1 + b_2X_2. \quad (2)$$

The standard error of estimate for market A was 3.65 cents. Thus, an estimated hauling charge per hundredweight computed for this market, based on these coefficients, would be within 3.65 cents (plus or minus) of the actual charge two-thirds of the time.

Table 5 shows the percentages of computed hauling charges, using equation (2), that were estimated within ½, 1, 2, and 3 cents of the actual charge per hundredweight. More than half the hauling charges were estimated within ½ cent of the actual charges in one market; at 1 cent, it was two markets; and at 2 cents, four markets. At 3 cents, estimated values ranged from 51.2 to 98.1 percent of actual charges for individual markets. On a combined market basis, however, estimated hauling charges were within 3 cents of actual charge only 42.3 percent of the time.

While these percentages indicated hauling charges could be estimated within specified ranges, the inherent error in the estimates might present problems if the estimated charge were used to determine a total hauling cost. For example, assume the actual hauling charge per hundredweight is \$0.35, and \$2.50 for two different hauling distances; load size is 400 hundredweight (approximately 4,700 gallons). Further, assume that by using this procedure, the estimated hauling charge is ½ cent and 3 cents, respectively, less than the actual charge. Based on the \$0.35 charge, these differences represent an underestimate of about 1 and 3 percent, respectively. On the \$2.50 charge, the underestimate is 0.2 and 1.2 percent. At 35 cents per hundredweight, the total charge for hauling 400 hundredweight is \$140; at \$2.50 per hundredweight, it is \$1,000. An underestimate of ½ and 3 cents in the charge per hundredweight results in the total hauling charge being underestimated by \$2 and \$12, respectively.

Table 5.--Percentage of individual market observations estimated within specified limits of actual hauling charge, using estimating equation, $\hat{Y} = a + b_1X_1 + b_2X_2$, seven Federal milk order markets, October 1969

Federal milk order market	Observations	Range of charges per hundredweight	Compared with actual hauling charge, estimated hauling charge within--				Total observations estimated within 3 cents
			½ cent	½-1 cent	1-2 cents	2-3 cents	
	Number	Dollars	Percent				
A	43	0.35-2.61	2.3	18.6	18.6	32.6	72.1
B	51	0.15-0.50	25.5	15.7	31.4	25.5	98.1
C	10	0.20-1.36	60.0	10.0	20.0	0	90.0
D	84	0.30-1.10	22.6	4.8	20.2	3.6	51.2
E	64	0.22-0.42	3.1	20.3	50.0	12.5	85.9
F	78	0.19-2.74	2.6	6.4	17.9	30.8	57.7
G	55	0.17-0.81	18.2	47.3	3.6	0	69.1
Seven markets combined	385	0.15-2.74	10.1	9.6	13.2	9.4	42.3

Charge per Hundredweight Mile Basis

Comparison of hauling charges, when arrayed on a charge per hundredweight and per hundredweight mile basis (table 2), suggests that better estimates might be obtained by using charge per hundredweight mile as the dependent variable (Y) in the regression function. Charge per hundredweight mile is obtained by dividing the hundredweight charge by the one-way hauling mileage. Using per hundredweight mile figure as the dependent variable in the regression function increases the interaction between the dependent variable and both independent variables--especially miles hauled (X_1)(table 6).

As shown in table 6, equation V might provide the best estimates of charges per hundredweight mile, that is, the largest number within specified limits such as 0.015 or 0.020 cent of the actual charge. Regression functions for equation V are based on the data being segmented into various load size combinations. Table 7 presents estimates of regression functions for the segmented load sizes.

R^2 values for three of the six categories indicate that much of the variation in the Y value (charge per hundredweight mile) is explained by or associated with other factors not included in the analysis, such as number of transport companies in an area or availability of transport equipment. Most of the variability associated with volume was eliminated by stratifying the shipments according to load size.

The standard errors of estimate, however, indicate that use of the a, b_1, and b_2 values in a segmented estimating equation, such as equation V, might supply estimated charges closer to actual charges.

Although equation V (table 6) estimated the hauling charge per hundredweight mile within 0.015 cent for 70.9 percent of the observations, and within 0.020 cent of the actual charge for 76.9 percent, testing limits of 0.001, 0.003, 0.005, and 0.010 cent were used with the data on a market-by-market basis. Table 8 shows, on a percentage basis, how effectively the segmented equation estimated hauling charges within these limits.

In four of seven markets, estimated charges were within 0.010 cent of actual charge 50 to 80 percent of the time. For all markets combined, it was 51.6 percent of total observations. In effect, the 0.010-cent difference translates into a possible estimating error or difference of 1 cent per hundredweight for each 100 miles that bulk milk is transported. At a 0.015 and 0.020 cent difference, this error would amount to 1.5 and 2.0 cents per hundredweight, respectively, for each 100 miles of hauling distance--about a 10-percent error.

Total Hauling Charge Basis

A new set of relationships was set up for analysis, using total hauling charges as the dependent variable. In this instance, the segmented equation format gave closer estimates of total charges than the unsegmented approach for some categories. Otherwise, as load size increased, it became less influential in explaining variation in hauling charges. Most out-of-market shipments are large loads; small volume shipments are the exception.

Table 6.--Comparison of estimated hauling charges with actual hauling charges, on a per hundredweight mile basis for seven experimental estimating equations, 1/ seven Federal milk order markets, October 1969 data

Equation number	Basis on which regression functions computed	Estimated charges calculated within				Total observations estimated within 0.020 cent of actual	
		0.015 cent of actual		0.020 cent of actual			
		Number	Percent of total	Number	Percent of total	Number	Percent of total
I	Observations for markets A, B, C, and F and segmented on basis of hauling distance	228	59.2	43	11.2	271	70.4
II	Same as equation I except observations not segmented on basis of hauling distance	218	56.6	84	21.8	302	78.4
III	Observations for all seven markets and not segmented on basis of hauling distance	198	51.4	46	11.9	244	63.4
IV	Observations for all seven markets and segmented on basis of hauling distance	193	50.1	43	11.2	236	61.3
V	Observations for all seven markets and segmented on basis of load size of hundredweights hauled	273	70.9	23	6.0	296	76.9
VI	Observations for markets A, B, C, and F and segmented on basis of load size of hundredweights hauled	221	57.4	63	16.4	284	73.4
VII	Observations for markets D, E, and G used and segmented on basis of load size of hundredweights hauled	189	49.1	59	13.3	248	64.4

1/ All experimental equations were tested using all 385 observations included in total sample.

Table 7.--Estimates of multiple linear regression functions for selected load sizes for out-of-market bulk milk shipments, seven Federal milk order markets, October 1969

Load size (hundredweights)	Observations	Average hauling charge per hundredweight mile, Y	Average one-way distance hauled, X_1	Average load size hundredweights hauled, X_2	Constant, a	Regression coefficients 1/ Distance hauled (miles), b_1	Regression coefficients 1/ Hundredweights hauled, b_2	R^2	Standard error of estimate
	No.	Cents	Miles	Cwt					Cents
Under 404.2 (4,700 gal.)	43	0.328	285.67	240.32	0.72917	-0.00012 (3.01)	-0.00153 (13.74)	0.88379	0.06540
404.2-447.2 (4,700-5,200 gal.)	49	.153	362.00	439.07	.85146	.00000 (.41)	-.00159 (6.66)	.51627	.01730
447.3-473.0 (5,200-5,500 gal.)	109	.159	811.61	464.62	.16882	-.00001 (2.04)	-.00001 (.04)	.38091	.01618
473.1-490.2 (5,500-5,700 gal.)	125	.152	413.64	482.92	.85867	-.00000 (.06)	-.00146 (5.13)	.18348	.01401
490.3-498.8 (5,700-5,800 gal.)	46	.169	246.00	493.26	-.72674	-.00005 (1.69)	.00184 (0.90)	.15285	.02319
498.9-559.0 (5,800-6,500 gal.)	13	.159	185.00	523.10	.20585	-.00026 (3.74)	-.00000 (0.02)	1.00000	.00000
All observations combined	385	.172	477.34	447.46	.44601	-.00002 (2.60)	-.00059 (18.76)	.49941	.05250

1/ T-values included in parentheses under regression coefficients.

Table 8.--Percentage of individual market observations estimated within specified limits of actual hauling charge using segmented estimating equation, seven Federal milk order markets, October 1969 data

Federal milk order market	Observations	Range of charges per hundredweight mile	Compared with actual hauling charge, estimated hauling charge within--				Total observations estimated within 0.010 cent
			0.001 cent	0.001-0.003 cent	0.003-0.005 cent	0.005-0.010 cent	
	Number	Cents	----------	----------	Percent	----------	----------
A	43	0.1268-0.1655	11.6	30.2	9.3	11.6	62.7
B	51	0.1298-0.2500	5.9	9.8	15.7	13.7	45.1
C	10	0.1478-0.1770	10.0	0	60.0	10.0	80.0
D	84	0.1419-0.1908	17.8	6.0	8.3	11.9	44.0
E	64	0.1508-0.2745	4.7	3.1	9.4	32.8	50.0
F	78	0.1357-0.2448	2.6	12.8	14.1	32.0	61.5
G	55	0.1376-0.7659	0	38.2	0	5.4	43.6
Seven markets combined	385	0.1268-0.2745	7.5	14.5	10.9	18.7	51.6

Stratification by load size limited the potential variation and influence of the X_2 (hundredweights hauled) within each stratum. The constants and the b_2 regression coefficients tended to alternate from positive to negative between strata of load sizes. However, all coefficients but one were significant at the 1-percent level. Although yielding the best technical estimates, the segmented approach did not appear to be the most practical.

A more general and readily applied expression of the relationships between charges, distance, and volume is available by combining observations for all load sizes and all markets in a single equation, as follows:

$$\hat{Y} = -68.88993 + 0.71068\ X_1 + 0.16279\ X_2 \tag{3}$$

$\hat{Y}$ = Estimated total hauling charge
Average Y = \$ 343.19
Average X_1 = 477.34 miles
Average X_2 = 447.46 hundredweight
R^2 = 0.981
b_1 and b_2 = Highly significant (1 percent level)
Standard error of estimate = \$42.57
Number of observations = 385.

Although this equation does not minimize the estimating error, it provides high-quality statistical estimates of the coefficients and expresses the average experience over the full range of observations available. It also lends itself to useful economic interpretation. The mileage coefficient (b_1 = 0.71068) represents the dollar increase in hauling charge associated with each 1-mile increase in one-way distance. For the average load size--447.46 hundredweight--and the average distance--477.34 miles, this amounts to 0.159 cent per hundredweight. A similar coefficient of 0.155 cent per hundredweight was given when computed on a charge per hundredweight basis (table 4).

For the combined market data, estimated hauling charges were within 10 percent of the actual charge 81.1 percent of the time. At the 5-percent level, it was 47.3 percent; 13.0 percent of the observations were estimated within 1 percent of actual total charges.

Although the format provides estimated total charges within a relatively narrow percentage range of the total hauling charge, the actual monetary difference could be very significant. For example, an error of 10 percent on a charge of \$70 would be \$7, whereas this would amount to \$10 on a \$100-charge. This amount of difference may not provide a sufficiently close estimate in either instance. A 1-percent difference, while being acceptable in terms of the dollar difference, would include only 13.0 percent of the estimates.

FINDINGS

Multiple regression analysis of the data for seven Federal milk order markets indicates milk hauling charges can be estimated within a relatively narrow range of the actual charge for various combinations of distances and load sizes. However, estimated charges, whether calculated by using the charge per hundredweight or per hundredweight mile, varied significantly above or below the actual total charge (table 9).

In the illustrative computations in table 9, the difference between the actual and estimated total charges was fairly small--2 percent of the total charge. Therefore, these formulations could be used to determine a range of hauling charges, either on a per hundredweight or per hundredweight mile basis, as well as the range in which the total hauling charges for a specified mileage and load size combination would fall. This range may be used to indicate the relationship between hauling distance, volume, and total charges.

Although distance and load size appear to be two dominant factors, the variability of the estimates from the actual charges indicates that there are other factors in the marketplace which affect the determination of actual hauling charges.

Table 9.--Comparison of differences between actual and estimated hauling charges calculated on a charge per hundredweight and per hundredweight mile basis, based on averages of market A data, October 1969

ITEM	VALUE CALCULATION
Data:	
Average charge per hundredweight 1/	$1.48
Average distance hauled 1/	983.5 miles
Average load size 1/	464.6 hundredweight
Average charge per hundredweight mile	0.150 cent ($1.48 ÷ 983.5 miles)
Assumed:	
Estimated charge per cwt	$1.45 (2% below $1.48 charge)
Estimated charge per cwt/mile	0.147 cent (2% below 0.150 cent charge)
Hundredweight basis:	
Actual total charge	$687.61 ($1.48 x 464.6 cwt)
Estimated total charge	$673.67 ($1.45 x 464.6 cwt)
Underestimate	$ 13.94
Hundredweight mile basis:	
Actual total charge	$685.40 (0.150 cent x 983.5 miles x 464.6 cwt)
Estimated total charge	$671.69 (0.147 cent x 983.5 miles x 464.6 cwt)
Underestimate	$ 13.71

1/ Average computed on basis of high and low of the range reported for market A.

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